Final Report

2002 Oak Survey of Mt. Wanda, John Muir National Historic Site

Prepared by:

Susan O'Neil
Natural Resources Specialist
Inventory and Monitoring Program
San Francisco Bay Area Network

March 2005

Introduction

The oak woodlands of California are a critical and sensitive plant community. Oak woodlands and savannas are considered by many to be one of the distinct and unique features of the state's landscape. The California Native Plant Society policy on oak hardwoods is to "support and encourage research about the ecology and distribution of native oaks" Due to the pressures historically and recently experienced by this plant community, on-going research and monitoring are necessary to determine how best to manage this natural resource on and off public land.

Blue oak woodlands alone encompass approximately 1.2 million ha in the state, much of which is on private land (Allen-Diaz and Holzman 1991). Oak woodlands are primarily located in the Coast Ranges and the foothills. Historic use of oak woodlands, savannas and riparian areas included firewood collection and grazing. More recent pressures include habitat fragmentation, loss of open space to development, and competition and displacement by invasive species. For some species of *Quercus* the disease Sudden Oak Death (SOD) is a primary concern for viability.

Sudden Oak Death was first seen in central and northern California in 1995. In 2000 researchers at University of California determined the cause of SOD to be *Phytophthora ramorum*, a previously unknown pathogen. Despite the name, it may actually take several months or years for the pathogen to kill a tree. The disease may take longer to kill certain species than others (Garbelatto *et. al* 2003). Sudden oak death is known to cause cankers, lesions, bleeding and can lead to death in members of the black and red oak group and a close relative of oaks, *Lithocarpus denisflorus*. On other host species, such as California bay and buckeyes, the pathogen sporulates and infects leaves without causing death (Garbelotto *et al.* 2003). There are currently over 20 host species that are naturally occurring in California (Garbelloto *et al.* 2003) with new species being added to the list regularly.

While SOD has the potential to threaten particular species of oaks in California, lack of regeneration is a serious threat to the long-term health and viability of all oak woodlands throughout California. Many studies have documented a lack of recruitment to the sapling stage. Grazing by livestock and deer are removing seedlings from the landscape before they can mature into saplings. Griffin (1976) found that deer were also eating acorns off *Quercus lobata* trees in the Santa Lucia Mountains. In the upper Carmel Valley, Griffin (1971) found that seedlings of nine *Quercus* species had to compete with annual grasses for water and space. Annual exotic grasses are the most typical understory in blue oak subseries throughout California (Allen-Diaz and Holzman 1991). Mensing (1992) concluded that since the 1860's almost no new *Q. douglasii* had been recruited at a Kern County study site. Only 3% of all trees in which age was determined dated to the period between 1984 and 1992. Griffin (1971) concluded that a reduction in browsing pressure would allow seedlings to mature into saplings in many habitats, and that if a good acorn crop and a wet year coincided with a reduction in the deer population, oak regeneration would be possible.

Poor recruitment to the sapling age class is most problematic for some species, including blue oak and valley oak, in certain regions of the state, including low elevation sites on south- and west-facing slopes (Tinnin 1996).

The objective of this study was to survey the existing oaks on Mt. Wanda to determine if natural regeneration is occurring. A secondary objective was to determine whether SOD was present at the site.

Study Site

The John Muir National Historic Site (JOMU) is part of the San Francisco Bay Area Network of National Parks (Fig. 1). It is located 40 miles northeast of San Francisco in Contra Costa County. The park acquired the 326 acre Mt. Wanda unit in 1990 (Fig. 2). The area had been grazed by cattle during the previous ownership. A vegetation map following the NPS-USGS standards was completed in 2004, and was not available during the time of this study. Four species of oak occur on Mt. Wanda: *Quercus agrifolia* (coast live oak), *Quercus kelloggii* (black oak), *Quercus douglasii* (blue oak) and *Quercus lobata* (valley oak). Of the four species, only black oaks and coast live oaks are susceptible to SOD. *Lithocarpus densiflora* does not occur on Mt. Wanda.

Based on the current vegetation map which follows the United State National Vegetation Classification System developed by Natureserve, the alliances included in the study are: blue oak woodlands, valley oak woodlands, coast live oak forest and California bay forest and mixed oak forest (O'Neil and Egan 2004). Oak woodlands cover 123 acres on the Mt. Wanda unit of the John Muir National Historic Site. Forest co-dominated by *Quercus agrifolia* (coast live oak) and *Umbellularia californica* (California bay) cover 116 acres on Mt. Wanda.

Methods

Sample site selection

For site selection, we used a 1:20,000 black and white digital orthophoto quadrangle (DOQ) from 2000 in ArcView 3.2 (ESRI, Redlands, CA). A single polygon was created to represent all areas of Mt. Wanda dominated or co-dominated by oak species (alliances later determined to be both oak woodlands and forests). Density was not considered in digitizing the polygon; therefore, areas considered woodland, savanna and forest were grouped as one large polygon. Using the AlaskaPak extension in ArcView, random points were automatically generated within the polygon of interest (Fig. 3). Thirty points were selected based on the time allocated to this project rather than basing the number of plots on a power analysis.

Field transects

The random points were located using a GPS unit (Trimble GeoExplorer III) and served as the starting point for the 50m transects. The direction of each transect from the starting point was selected arbitrarily. It was impractical to run all transects in the same direction due to the shape of the oak woodland polygon. To cover as much different area as possible, an effort was made to run transects in opposite directions when points were clustered. In cases where the random starting point was within 50m of the polygon boundary, the direction of the transect was selected to head towards the inside of the polygon.

Each tree within 2m of the transect was counted along the 50m transect. A field tape was used to mark transect length and observers counted trees which occurred within 1m on either side of the tape. A tree did not have to be rooted in the transect; therefore, overhanging canopy was included in the transect totals. The total area for each transect was $100m^2$. The long and skinny transects were used rather than a square $100m^2$ plot to reduce the variability on each transect. Also, this technique tended to be faster based on field trials. The reduction in variability was not tested in the field but stands to reason since the density of oaks vary based on species, slope and aspect displaying patchiness on the overall landscape (Elzinga *et al*. 2001).

Along each transect the number of seedlings, saplings and adult oaks were counted. Saplings were defined as the transitional stage between seedling and overstory trees (Swiecki and Bernhardt 1998) and growing above the browse line (5 feet) (Tinnin 1996). The total canopy cover was noted (0-25%; 25-50%, 50-75% and 75-100%) to give a rough estimate of the overall density of the stand. The datasheets also included information on the actual starting locations (sometimes slightly off from the randomly generated points due to GPS error in the field) and transect directions. Data on other species known to be possible SOD hosts or common associated trees were also included. These species are: *Umbellularia californica* (California bay), *Aesculus californica* (Buckeye), *Heteromales arbutifolia* (Toyon), *Rhamnus californica* (Coffeeberry), and *Lonicera hispidula* (Honeysuckle). For non-oak species, saplings may have been lumped with seedlings (particularly for *Umbellularia* californica) because they were not the focus of the study. Comments were also noted on the datasheet.

Results

Twenty-six of the 30 transects were completed; a lack of time during the field season limited the completion of all transects. Transects not included were #1, #20, #22 and #23 (Fig 2). Based on the more recently developed vegetation map, the vegetation alliances included in study are: valley oak woodland, blue oak woodland, coast live oak forest and California bay forest and mixed oak forest (Fig 3).

During the 2002 field season, all black oak (*Quercus kelloggii*) adults on Mt. Wanda were mapped as points using a Trimble GeoExplorer III unit. All black oaks were located on the north side of Mt. Wanda which is also a north-facing slope. Several starting points were randomly located in this area ensuring that the study included detection of all oak species on Mt. Wanda (Fig. 4).

No saplings of any oak species were detected in the study. It is likely that there were several California bay (*Umbellularia californica*) saplings, but during the study only oaks were being measured for seedling versus sapling size differences. The results are consistent with other oak surveys in California with a high percentage of seedlings in the understory and the remainder of the trees as adults, often estimated at over 100 years or more (Fig.5, 6).

Consistent with the cover of blue oak woodland on Mt. Wanda, the majority of adult trees found in the study were *Q. douglasii* (284). Blue oaks were also the only species which had more adults (166) than seedlings (118). California bay represented the most seedlings of any species (199; 247 trees total) which is remarkable since bays are not found in open woodland or savanna on Mt. Wanda.

Of the non-oak species included in the study, only *Aesculus californica* had as many individuals (22) as a *Quercus* species in the study (Appendix A). No individuals of *Rhamnus californica* or *Lonicera hispidula* were detected. No signs of SOD were found on any individual trees regardless of species.

Conclusions

Because native oaks are long-lived, a single regeneration survey is not enough to determine if a problem exists in an area (Tinnin 1996). Episodic recruitment followed by periods of little to no recruitment might be part of the normal regeneration in oaks, similar to other California ecosystems such as chaparral.

While deer and other herbivores are present on Mt. Wanda and may continue to prevent seedlings from becoming established saplings, there is no longer any livestock grazing on Mt. Wanda. In 1996, when the National Park Service acquired the land, all cattle grazing ceased. Swiecki and Bernhardt (1998) suggest that livestock grazing more adversely impacts blue oaks than grazing by deer due to soil compaction and the reduction or elimination of the litter layer beneath trees. Perhaps with the removal of cattle, some oak seedlings will be able to recruit to the next class size. Livestock grazing may also impact other woody species with the exception of less palatable species such as *Quercus agrifolia* (Swiecki and Bernhardt 1998). If bay trees are also less palatable to livestock, that may explain the high percentage of this species in the current study.

Exotic grasses are a significant understory in the *Quercus lobata* and *Quercus douglasii* woodlands on Mt. Wanda. If the grasses compete with acorns for space, light and water, there may be fewer seedlings germinating than prior to the exotic grass invasion. Griffin (1971) showed that in experimental plots, the grassy areas had no seedling establishment or survival and a variety of oak seedlings survived in grassless areas. However, based on the results of this 2002 survey, there does not seem to be a lack of seedling establishment. Instead, the limiting factor is in recruitment from the seedling stage to the sapling stage.

Symptoms of SOD or *Phytophthora ramorum* infection have not been seen in the park or adjacent areas during or since this study. Contra Costa County has been considered an infected county since 2002 due to isolates from *Q. agrifolia* and *U. californica* from Wildcat Canyon, East Bay Regional Park District land (COMTF 2002). The park is outside of the summer fog-belt which may assist in prevention of SOD (past research indicates this may be a factor); however, the park also has areas with a high canopy cover of overlapping California bays and Coast live oaks which seems to be prime habitat with the spores moving from bay to oak in wet years (Garbelloto *et al.* 2003)).

<u>Recommendations</u>

The 2002 survey should be considered a pilot study because only 26 of the 30 transects were completed during the study and there may have been some confusion about seedlings and saplings in the dataset. The data should not be used as baseline for continued monitoring of oak regeneration. While the results are most likely representative of what is occurring on Mt. Wanda, the study design and sample size should be improved for long-term monitoring. In the future, saplings of all species should be included in the data, not just oak species. This is particularly important because there may be a shift in dominance to *Umbellularia californica* in moist areas currently co-dominated by *Quercus agrifolia*.

Retain the no-planting policy of sapling oaks from nurseries. In the past (pre-2002), the National Park Service had a policy of replacing each apparently dead adult oak tree that was noted by planting a replacement (Thurman, NPS). These plantings primarily occurred in the lower meadow along Alhambra Valley Road and in a fenced area next to the trailhead to the Nature Trail on Mt. Wanda. This practice ceased as of 2002 because the trees were being purchased from farms which did not collect the acorns from a local (within the Alhambra Watershed) source. There is sufficient evidence that the oaks are able to establish from acorns given the abundance of seedlings, so planting trees is not necessary. Caging seedlings and saplings may be an appropriate management strategy in the future with more information on the cause of low sapling numbers.

Research needs include: 1.) sapling survival; 2.) herbivory pressures; and 3.) competition. Further research is also needed to determine if a lack of saplings is a remnant of past grazing or if there is currently sufficient browsing by deer or other herbivores on the site to prevent seedlings from maturing into saplings. On a state-wide level there is on-going research into the impacts of grazing, the regeneration of oaks and SOD. The recommendation is that NPS managers keep abreast of these studies and work with the Contra Costa County UC Extension office on management techniques for oak woodlands. On-going education and monitoring are needed to detect a *Phytophthora ramorum* infection should it occur on Mt. Wanda.

The San Francisco Bay Area Network Inventory & Monitoring Program selected oak communities as a vital sign for long-term ecological monitoring. On-going monitoring is planned by the Inventory & Monitoring Program at the John Muir NHS for landbirds, water quality, invasive species and potentially plant community change. The results of this study and examination of the literature demonstrate that it is necessary to monitor changes in the oak woodlands over time, and that oak woodlands should be a focal community if and when plant community change monitoring is established at as part of long-term ecological monitoring..

Acknowledgements
This project began due to the former John Muir NHS Chief of Maintenance, Herb Thurman, who was concerned about the oaks on Mt. Wanda. Emily Klokkevold, Student Conservation Association intern, provided valuable field assistance, data entry and analysis. The SFAN Inventory & Monitoring program provided the time of Susan O'Neil, Network Natural Resource Specialist, the unlimited use of a Trimble GeoExplorer III, and computer support. Special thanks to the former Superintendent of John Muir NHS, Glenn Fuller, for full support on any and all projects concerning natural resources on Mt. Wanda. Jennifer Bjork, SFAN Inventory Coordinator, and Sarah Allen, Point Reyes Science Advisor, provided useful comments on the report and were very understanding about it being two years late.

Literature cited

Allen-Diaz, B.H., B.A. Holzman. 1991. Blue oak communities in California. *Madroño* 38(2): 80-95.

California Oak Mortality Task Force. 2002. "Report to the California Oak Mortality Task Force – July". Handout for UC Extension training.

Elzinga, C., D. Salzer, J. Willoughby, and J Gibbs. 2001. *Measuring and Monitoring Plant and Animal Populations*. Blackwell Science. Massachusetts, U.S.A. 360 pp.

Garbelatto, M., J.M Davidson, K. Ivors, P.E. Maloney, D Huberli, S.T. Koike, D.M. Rizzo. 2003. Non-oak native plants are main hosts for sudden oak death pathogen in California. *California Agriculture* 57(1): 18 – 23.

Griffin, J. 1971. Oak regeneration in the upper Carmel Valley, California. *Ecology* 52(5): 862-868.

Griffin, J. 1976. Regeneration in *Quercus lobata* savannas, Santa Lucia Mountains, California. *The American Midland Naturalist* 95(2): 422-435.

Mensing, S.A. 1992. The impact of European settlement on blue oak (*Quercus douglasii*) regeneration and recruitment in the Tehachapi Mountains, California. *Madroño* 39(1): 36-46.

O'Neil, S.E. and S. Egan. 2004. Vegetation mapping project of Mt. Wanda, John Muir National Historic Site. National Park Service report. 42 pp.

Swiecki, T.J. and E. Bernhardt. 1998. Understanding blue oak regeneration. *Fremontia* 26(1): 19-26.

Tinnin, P (editor). 1996. Guidelines for managing California's hardwood rangelands. University of California Division of Agriculture and Natural Resources Publication 3368.

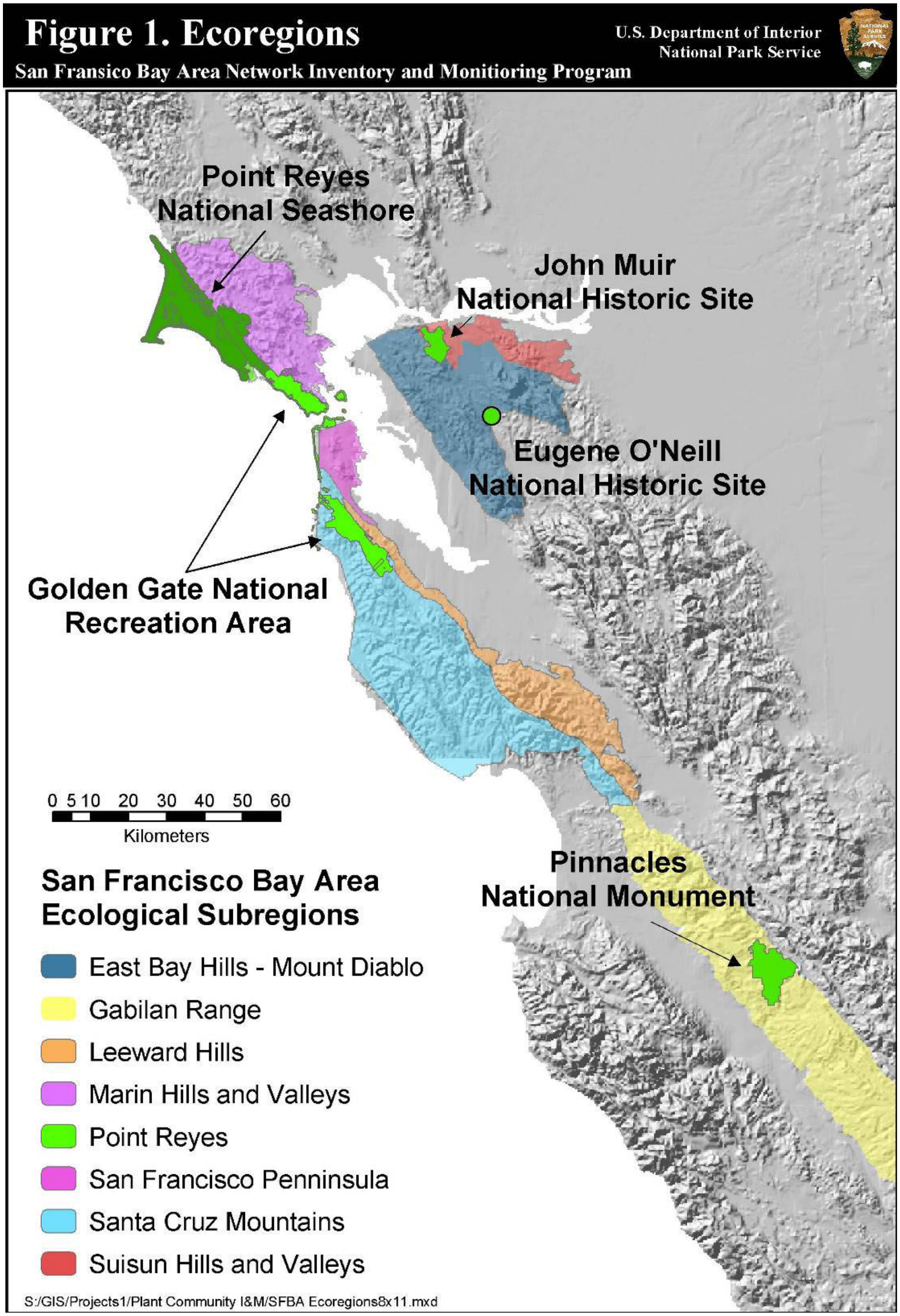

Figure 1.
Location of John Muir NHS and Ecoregions of the
San Francisco Bay Area.

Figure 2.
Management Units of John Muir NHS.

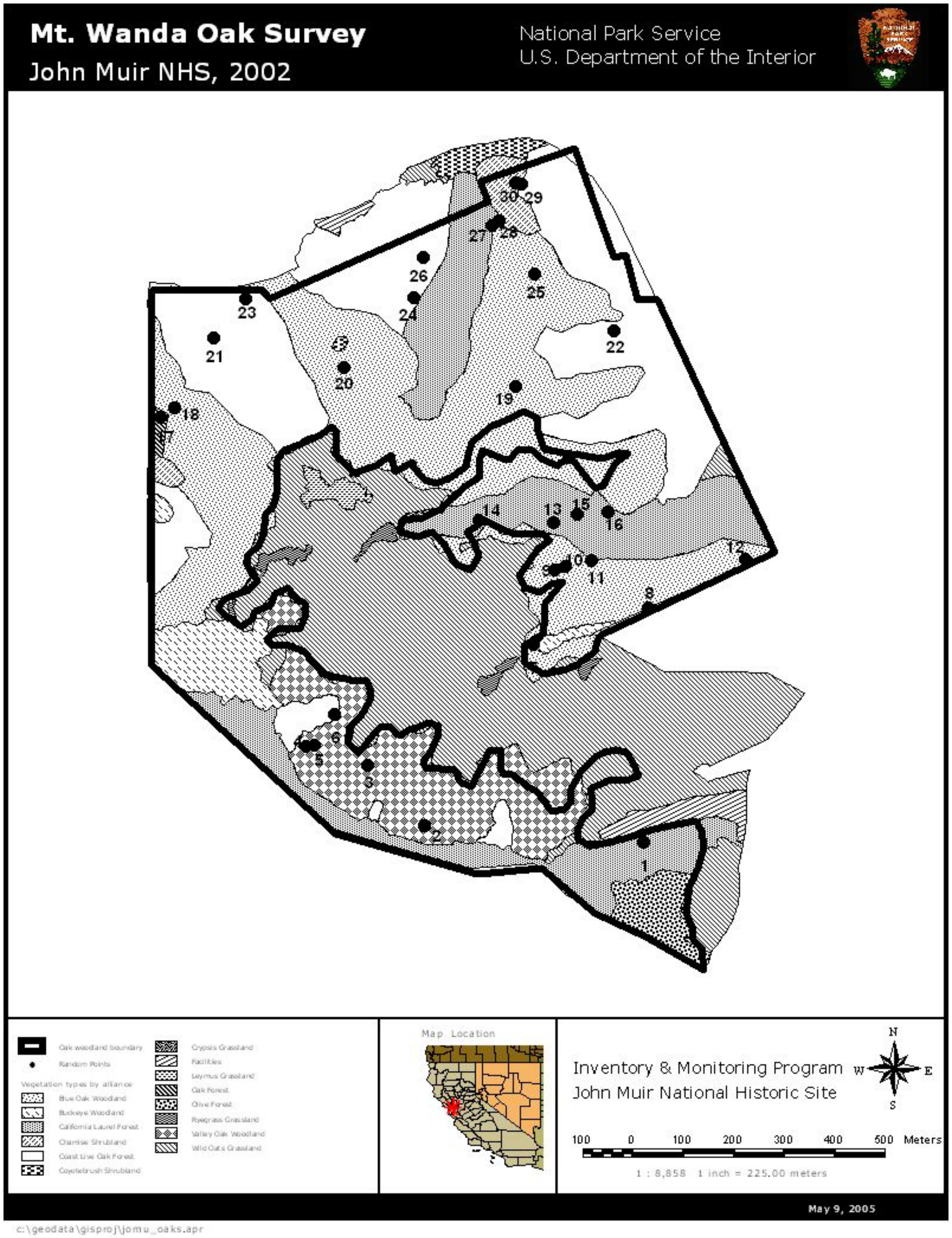

Figure 3.
Random points and 2002 oak polygon overlaid on
2004 Mt. Wanda vegetation map.

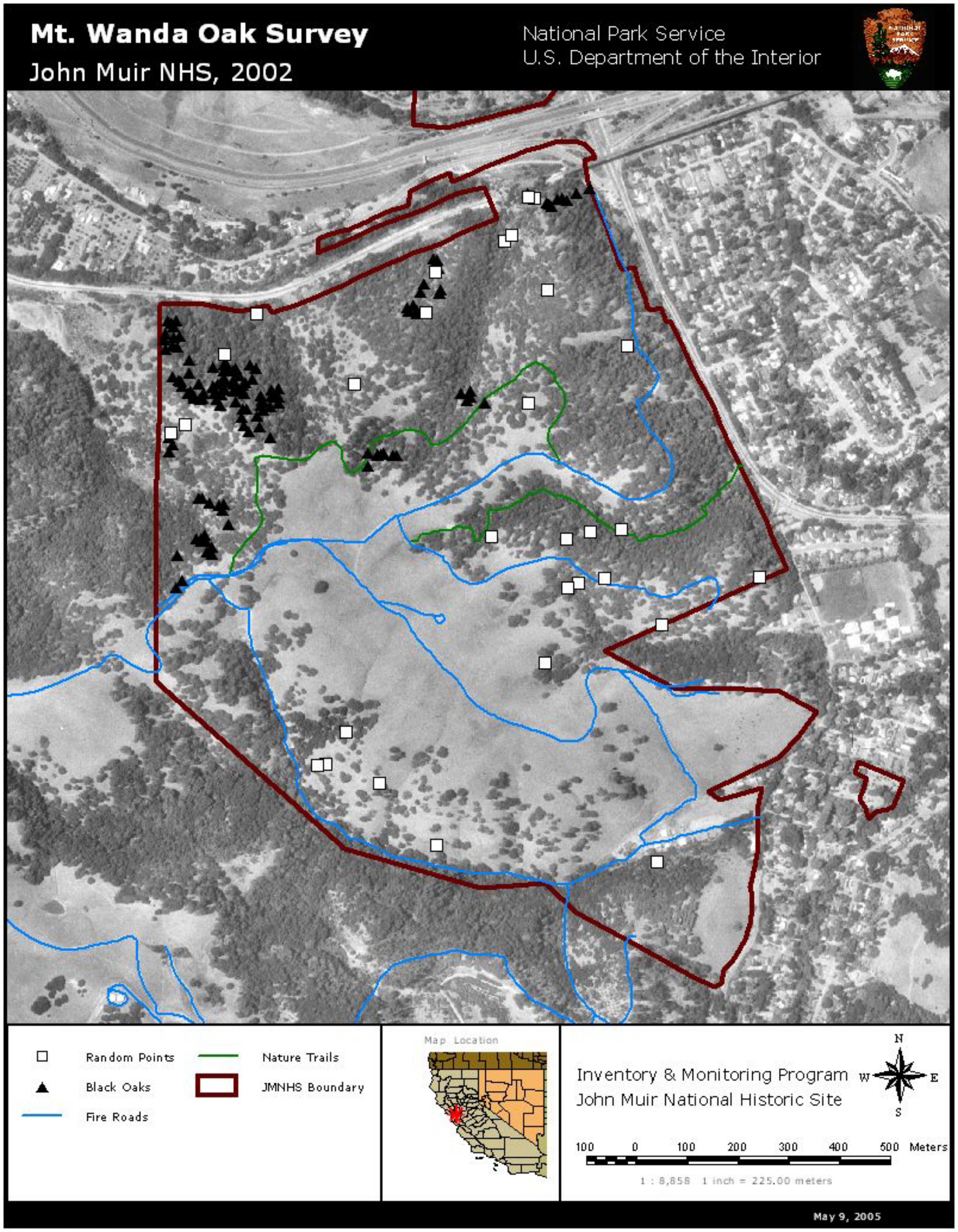

Figure 4.
Mt. Wanda with location of black oak
and random start points for oak transects.

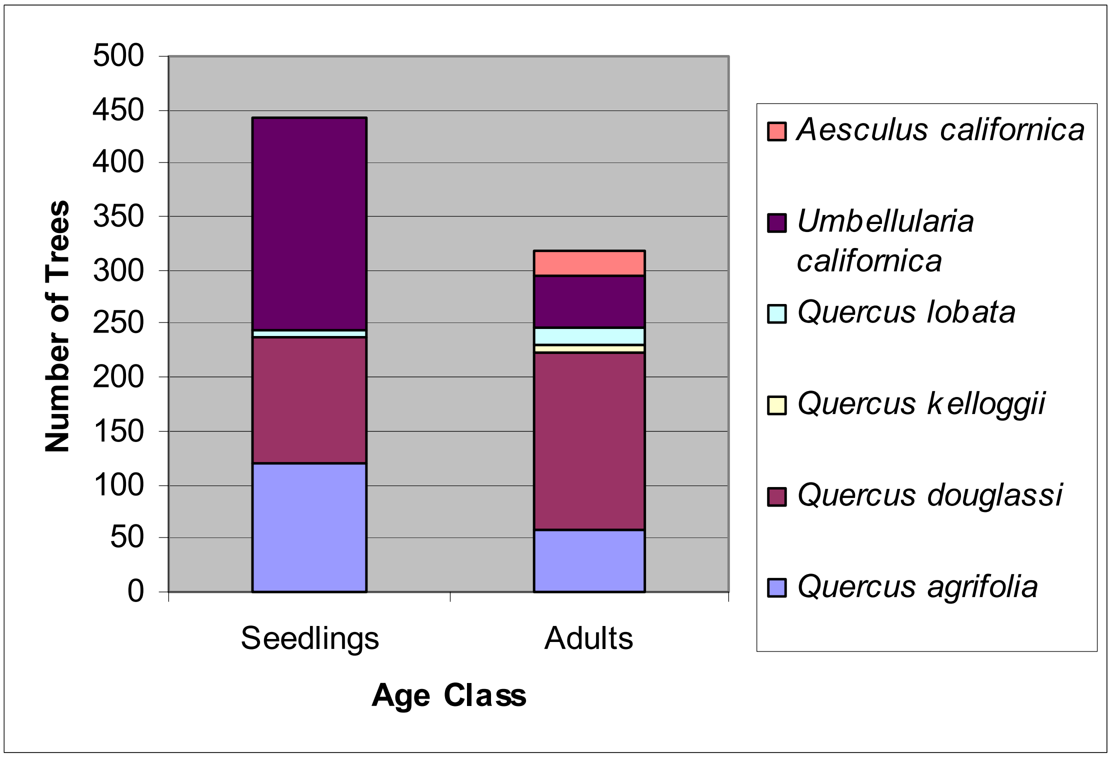

Figure 5.
Number of trees by age class on Mt. Wanda, 2002.

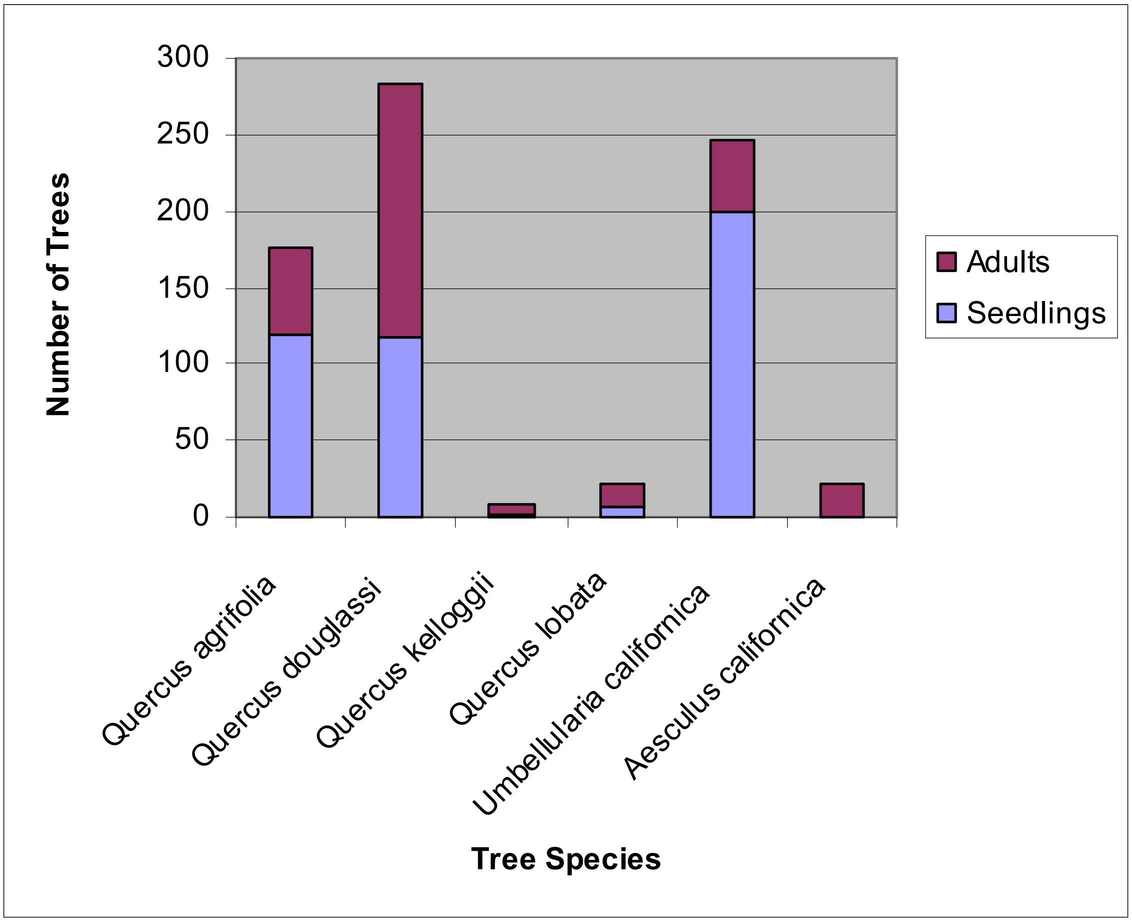

Figure 6.
Number of trees by species on Mt. Wanda, 2002.

Appendix A. Data for 50m transects on Mt. Wanda, August 2002.

TREE SURVEY ON MT. WANDA, 2002 (50 m transects)

Transect #	Date Completed	Start Northing	Start Easting	Direction (degrees)	Total Canopy Cover (%)	**Total Quercus agrifolia**	Seedlings	Adults	**Total Quercus douglasii**	Seedlings	Adults	**Total Quercus kelloggii**	Seedlings	Adults	**Total Quercus lobata**	Seedlings	Adults	**Umbellularia californica**	Seedlings	Adults	**Aesculus californica**	**Heteromeles arbutifolia**	**Rhamnus californica**	**Lonicera hispidula**
1						0			0			0			0			0						
2	8/9/02	4203692	576093	325	0-25	1	0	1	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0
3	8/19/02	4203813	575982	160	0-25	4	3	1	3	1	2	0	0	0	2	0	2	2	2	0	0	0	0	0
4	8/9/02	4203849	575860	155	0-25	7	6	1	17	14	3	0	0	0	1	0	1	1	1	0	0	0	0	0
5	8/9/02	4203851	575875	50	0-25	3	2	1	8	6	2	0	0	0	1	0	1	0	0	0	0	0	0	0
6	8/19/02	4203913	575916	300	25-50	30	24	6	0	0	0	0	0	0	3	0	3	23	22	1	0	0	0	0
7	8/16/02	4204050	576308	70	25-50	5	5	0	19	17	2	0	0	0	7	5	2	3	3	0	8	0	0	0
8	8/16/02	4204124	576537	50	0-25	0	0	0	22	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0
9	8/7/02	4204198	576352	140	25-50	5	2	3	15	3	12	0	0	0	0	0	0	0	0	0	5	0	0	0
10	8/7/02	4204206	576373	130	25-50	0	0	0	28	9	19	0	0	0	0	0	0	0	0	0	0	0	0	0
11	8/7/02	4204217	576423	75	25-50	0	0	0	16	1	15	0	0	0	0	0	0	2	2	0	0	0	0	0
12	8/15/02	4204220	576729	340	25-50	3	0	3	3	0	3	0	0	0	1	0	1	9	7	2	4	0	0	0
13	8/15/02	4204293	576348	280	25-50	0	0	0	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
14	8/15/02	4204298	576201	60	0-25	5	0	5	2	0	2	0	0	0	0	0	0	10	10	0	1	0	0	0
15	8/15/02	4204308	576396	115	50-75	11	8	3	10	2	8	0	0	0	0	0	0	72	67	5	2	0	0	0
16	8/15/02	4204313	576458	120	75-100	7	2	5	0	0	0	0	0	0	0	0	0	21	5	16	2	0	0	0
17	8/13/02	4204502	575570	154	25-50	9	6	3	49	37	12	2	1	1	0	0	0	0	0	0	0	0	0	0

18	8/13/02	4204520	575600	106	0-25	0	0	0	11	5	6	0	0	0	1	0	1	0	0	0	0	0	0	0	
19	8/12/02	4204561	576273	240	0-25	0	0	0	7	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	
20						0			0			0			0			0							
21	8/13/02	4204590	575681	90	50-75	18	17	1	0	0	0	5	0	5	3	1	2	9	8	1	0	0	0	0	
22						0			0			0			0			0							
23						0			0			0			0			0							
24	8/12/02	4204738	576072	170	25-50	1	1	0	17	2	15	0	0	0	0	0	0	0	0	0	0	0	0	0	
25	8/12/02	4204784	576312	80	25-50	4	0	4	18	4	14	0	0	0	0	0	0	0	0	0	0	0	0	0	
26	8/12/02	4204818	576092	244	50-75	5	4	1	9	0	9	2	0	2	1	0	1	17	10	7	0	0	0	0	
27	8/19/02	4204880	576227	200	75-100	17	11	6	2	2	0	0	0	0	0	0	0	37	27	10	0	0	0	0	
28	8/19/02	4204891	576241	270	0-25	18	16	2	0	0	0	0	0	0	0	0	0	34	29	5	0	1	0	0	
29	8/19/02	4204964	576285	130	25-50	3	0	3	8	2	6	0	0	0	0	0	0	1	0	1	0	0	0	0	
30	8/19/02	4204966	576275	252	0-25	20	12	8	3	2	1	0	0	0	0	0	0	6	6	0	0	0	0	0	
TOTALS						**176**	119	57	**284**	118	166	**9**	1	8	**22**	6	16	**247**	199	48	**22**	**1**	**0**	**0**	